SCHOOL OF
CIVIL ENGINEERING

INDIANA
DEPARTMENT OF TRANSPORTATION

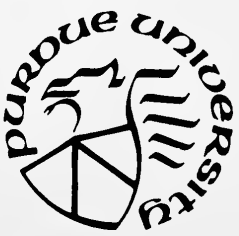
JOINT HIGHWAY RESEARCH PROJECT

FHWA/IN/JHRP-91/5-2

Executive Summary

THE DEVELOPMENT OF A HIGHWAY REVENUE FORECASTING MODEL FOR INDIANA

Amiy Varma
Kumares C. Sinha
Jeffrey L. Spalding



PURDUE UNIVERSITY

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The Development of a Highway Revenue Forecasting Model for Indiana

Executive Summary

TO: Vincent P. Drnevich, Director
Joint Highway Research Project

January 8, 1991
Revised January 22, 1992
Project: C-36-73J

FROM: Kumares C. Sinha, Associate Director
Joint Highway Research Project

File: 3-4-11

Attached is the Final Report on the HPR Part I Study titled, "The Development of a Highway Revenue Forecasting Model for Indiana." This report presents the forecasts of highway revenues for Indiana under various scenarios and details the operation of a computer model developed for the same. This research was conducted by Amiy Varma under my direction.

This report is forwarded for review, comment and acceptance by the INDOT and FHWA as fulfillment of the objectives of the study.

Respectfully submitted,

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The Development of a Highway Revenue Forecasting Model for Indiana

Executive Summary

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16. Abstract

This report present a state highway revenue forecasting model developed for Indiana Department of Transportation. The package provides both long range annual forecasts as well as short range monthly forecasts of highway revenues by source. An important feature of the model is its ability to adopt new parameters and input data in order to avoid obsolescence. The model can be used to determine expected amounts of revenues under existing taxation structures as well as to assess impacts of possible changes.

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Introduction

State transportation agencies are facing challenges arising from cost uncertainties resulting from economic instability; escalation of construction, maintenance, and operating costs; and erosion of revenues due to instability of some of the revenue bases, in particular motor fuel taxes, resulting from vehicular technological advancements. Proposed shifts in revenue sources from federal to state and local governments would further add to these challenges. Under such circumstances the agencies are realizing: (a) the need to develop and periodically update forecasts for a variety of revenue sources for planning and budgeting purposes; and (b) that they must do so under constraints of limited data, technical skills and budget resources.

The primary purpose of this study was to develop a computerized highway revenue forecasting model for the Indiana Department of Transportation (INDOT) which could provide both long-term and short-term forecast of highway revenues by source. An exhaustive literature review, extensive data collection, and analyses of revenue and travel-related data were conducted to develop the regression and other models which form the basis of the computerized system. The final system is responsive to socio-economic, technological, and legislative policy changes.

Indiana Highway Revenues and Their Disbursement

Major sources of highway revenue are federal aid, motor fuel taxes, vehicle registration fees, driver license fees, and revenue

bonds. For 1991 38 % of INDOT's total highway revenues were from federal-aid and 2 % from other miscellaneous sources. The remaining portion is made up of motor fuel taxes, vehicle registration fees, and driver license fees. In 1987, Indiana joined International Registration Plan (IRP) which was aimed at distributing fairly the registration fees paid by the long-haul heavy trucks (above 26,000 lbs and/or having more than two axles) among the different states whose highway facilities were used.

The distribution of highway revenues in Indiana center around two major accounts, the Motor Vehicle Highway Account (MVHA) and the Highway Road and Street Fund (HRSF). Other revenue accounts include the Special Distribution (SD), State Highway Road Construction & Improvement Fund (SHCF), and the Motor Carrier Regulation Fund (MCRF). Highway revenues are distributed to these funds according to legislated ratios.

Long-Term Highway Revenue Forecasting Methodology

This study disaggregates total revenues into the revenues obtained from the six major sources--registration fees, driver licenses, gasoline tax, special fuel tax, diesel surtax, and motor carrier fuel use tax. The revenues from each source can be further separated into component parts (tax rate and revenue base). Figures 1 and 2 indicate the overall structure of how vehicle registration revenues are estimated. The overall procedure to obtain the annual VMT by different vehicle categories is shown in Figure 3. Fleet fuel efficiency is based on the consideration

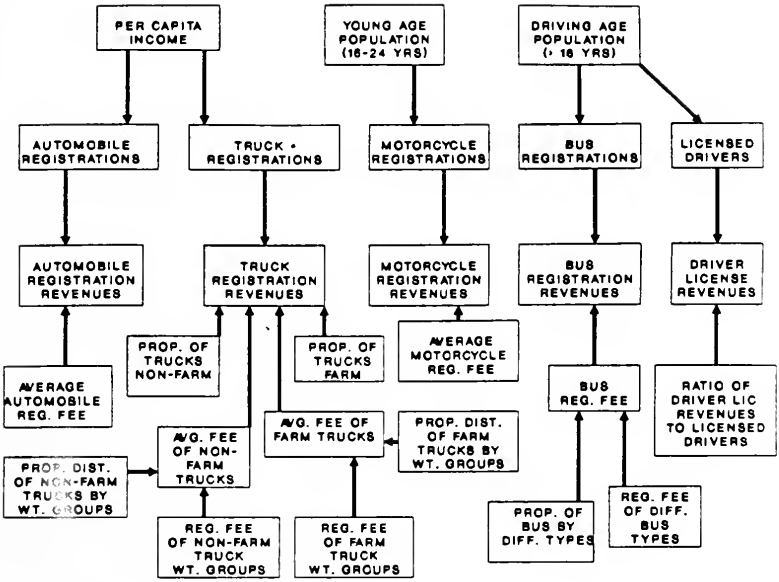


Figure 1. Overall Procedure to Compute Automobile, Truck, Bus, and Motorcycle Registration Revenues and Driver License Revenues

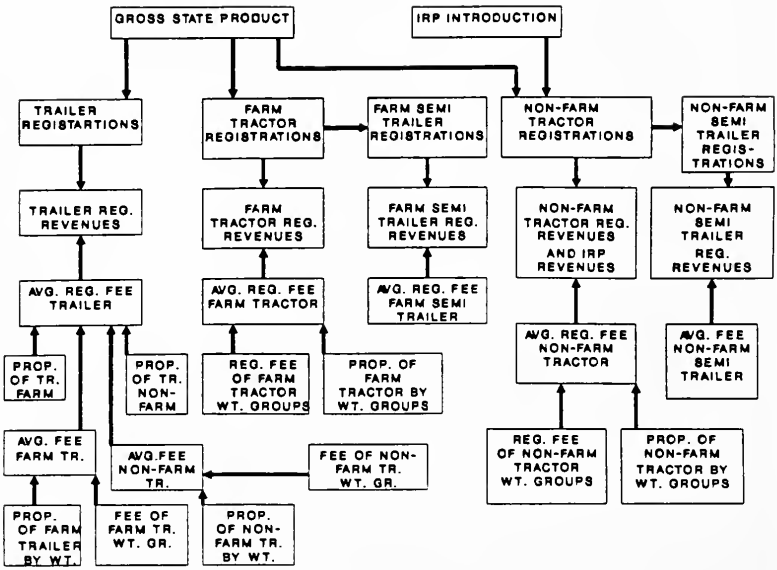


Figure 2. Overall Procedure to Compute Tractor, Trailer, and Semitrailer Registration Revenues

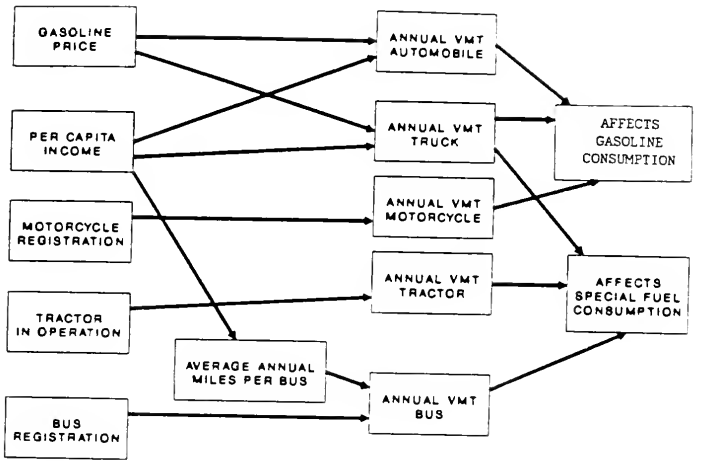


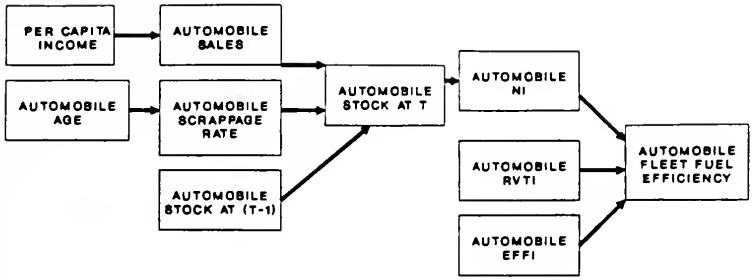
Figure 3. Overall Procedure to Compute Annual VMT by Different Vehicle Categories

of vehicle sales and scrappage rates, and technological factors affecting the fuel efficiency of new vehicles. Figures 4, 5 and 6 indicate the computational procedure for estimating fleet fuel efficiencies of automobiles, trucks, and tractors respectively. The fleet fuel efficiency of buses for the purpose of this study has been assumed to be same as that of tractors. The VMT and fleet fuel efficiencies are used to compute the fuel consumption. The overall structure for estimating motor fuel tax revenues is shown in Figure 7.

The most widely used short-term forecasting method is the decomposition method. The basic aim in the decomposition method is to find the seasonality existent in the revenue or other data; and thus, distribute the annual forecast to monthly estimates using the seasonal factors computed. Such an approach has been adopted for determining the monthly forecasts in this study. Short-term forecasts are made using an alternative approach which uses: a) trend projections of the seasonally adjusted data; and b) the seasonal factors. The trend projections are made using time periods.

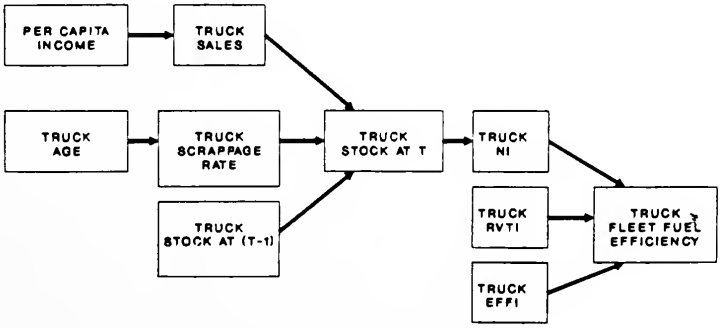
Modeling

Several linear regression, non-linear regression and other models were established for vehicle registrations, vehicle sales, vehicle scrappage, vehicle travel, and vehicle fleet fuel efficiency. Demographic data used in developing relationships were total population, driving age population (above 16 years old),



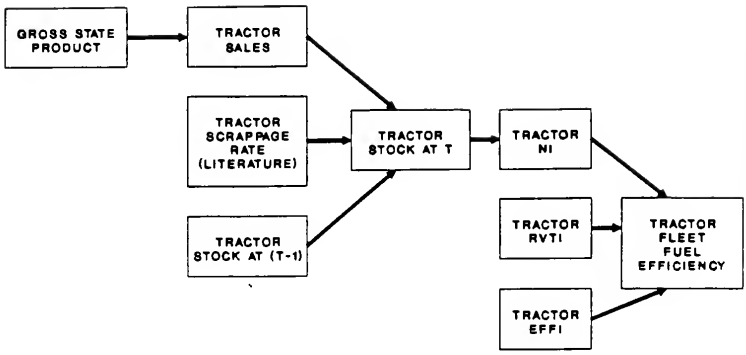
NOTE: NI IS PROPORTION OF AUTOMOBILE IN ITH AGE COHORT
RVTI IS RELATIVE VEHICLE USE BY AUTOMOBILE IN ITH AGE COHORT
EFFI IS THE FUEL EFFICIENCY OF AUTOMOBILE IN ITH AGE COHORT

Figure 4. Procedure to Compute Fleet Fuel Efficiency of Automobiles



NOTE: NI IS PROPORTION OF TRUCK IN ITH AGE COHORT
RVTI IS RELATIVE VEHICLE USE BY TRUCK IN ITH AGE COHORT
EFFI IS THE FUEL EFFICIENCY OF TRUCK IN ITH AGE COHORT

Figure 5. Procedure to Compute Fleet Fuel Efficiency of Trucks



NOTE: NI IS PROPORTION OF TRACTOR IN ITH AGE COHORT
RVTI IS RELATIVE VEHICLE USE BY TRACTOR IN ITH AGE COHORT
EFFI IS FUEL EFFICIENCY OF TRACTOR IN ITH AGE COHORT

Figure 6. Procedure to Compute Fleet Fuel Efficiency of Tractors

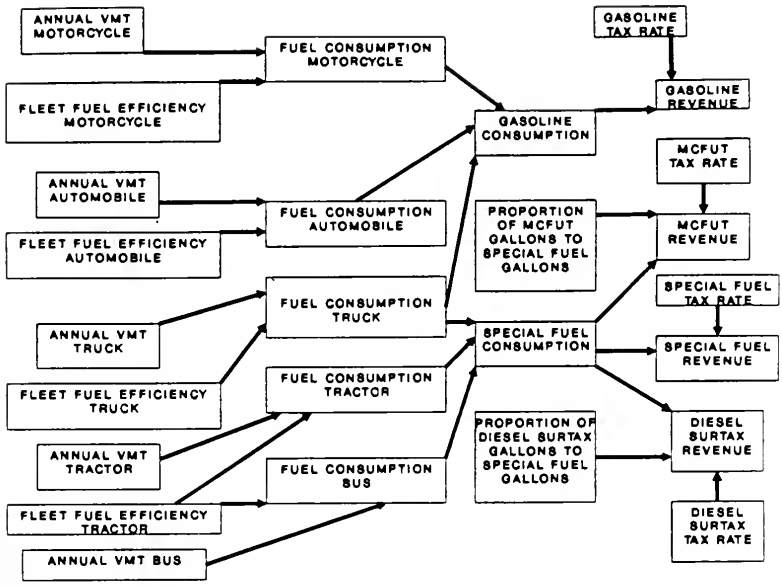


Figure 7. Overall Procedure to Compute Motor Fuel Tax Revenues

young age population (population between 16 years and 25 years old), and less than driving age population (less than 16 years old). Economic variables used in this study are per capita income in 1982 dollars in Indiana, gross state product in thousands of 1982 dollars, national Consumer Price Inflation (CPI) index, national Gross National Product (GNP) implict price deflator, and gasoline price in dollars. The established linear and non-linear regression relationships have R^2 (most above 0.80) and F-values (most above 3.0) indicating that the dependent variables correlate very well with independent variables, and that the independent variables are significant. These models are then integrated into a computerized program, INDOTREV, which uses an input file "DATA" to provide forecasts. The computerized model provides both short and long term forecasts and offers the users the ability to conduct sensitivity analyses. Being menu driven, the system is user friendly. The updating (which is most essential in any forecasting process) of the program can be performed by just updating the "DATA" file. The process of updating the "DATA" file is discussed in detail in Chapter 8 of this report. The flexibility of updating prevents the obsolescence of the model. As the new data becomes available the user can update both the relationships used and the input data through the "DATA" file. The SHORTREV program computes new seasonal factors and trend equations as the new data is entered in the files--GASIN (gasoline data file), SPFIN (special fuel data file), STAXIN (diesel surtax data file), MCFUTIN (motor carrier fuel use tax data file), REGIN (vehicle license fee data file), and

IRPIN (IRP data file). The SHORTREV program provides forecasts for six months in future from the last month in the respective data files.

Results

Nearly all of the revenue estimations were within 5% error, and the total revenue estimation (without revenues from sources such as federal reimbursement, general funds, etc.) was within 1% error. Somewhat less reliable segments were the estimation of IRP revenues, Motor Carrier Fuel Use Tax (MCFUT) revenues and Diesel Surtax revenues. Much of this had to do with the data limitations in studying the underlying phenomena behind the revenue generation from these sources. The forecasts of short-term gasoline and special fuel gallonage were within 10 % error for most of the months. For other categories, MCFUT and diesel surtax the variability of short-term forecasts from observed values was much more than found in the other two motor fuel tax categories essentially due to inadequate data. The quarterly estimations obtained by the execution of the SHORTREV program were within 10% for all revenue sources except MCFUT and IRP. The long-term results indicate that overall highway revenues are going to increase 23.8 % in current dollars by the year 2005. For the same period, registration revenues (excluding IRP revenues) are going to increase by 31.3 % in current dollars, gasoline revenues by 27.34%, special fuel revenues, as well as MCFUT and motor carrier surtax revenues by 14.39%. Thus we see that the revenues from vehicles

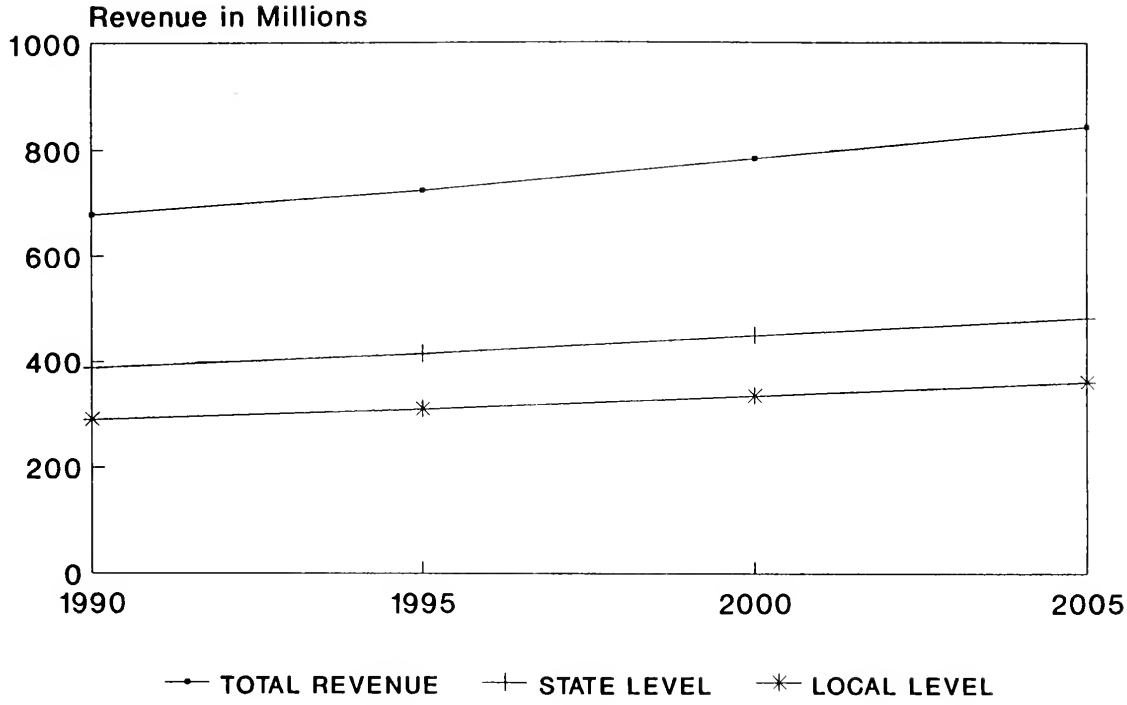


Figure 8. Forecasts of Highway Revenues at State and Local Levels

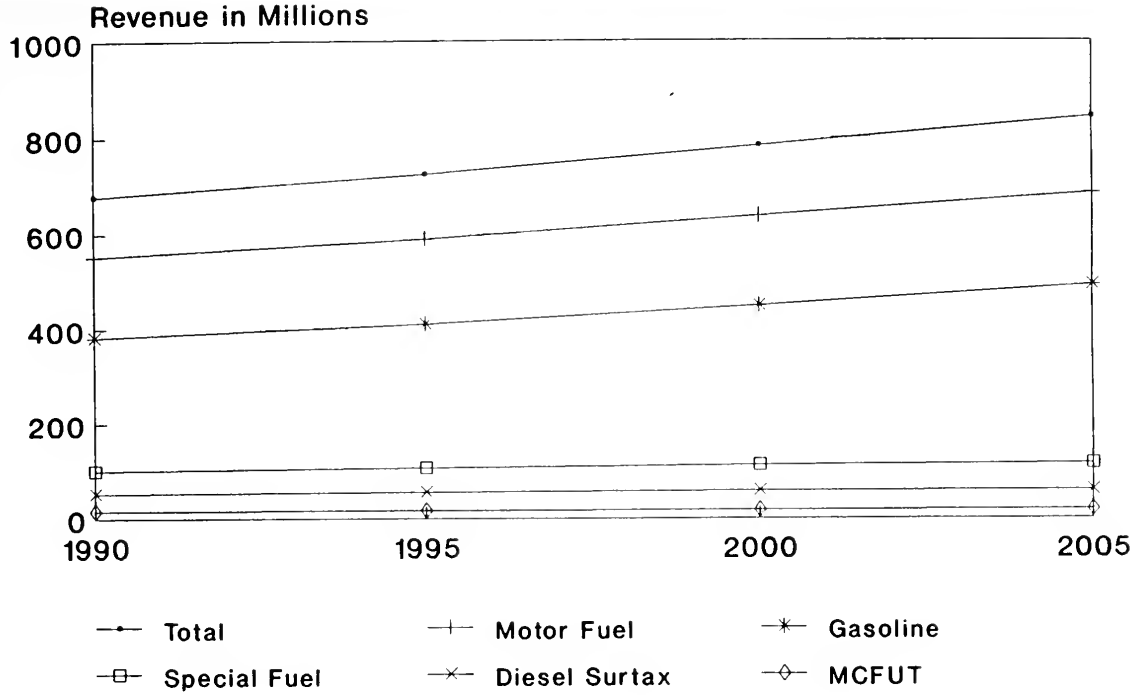


Figure 9. Forecasts of Motor Fuel Revenues

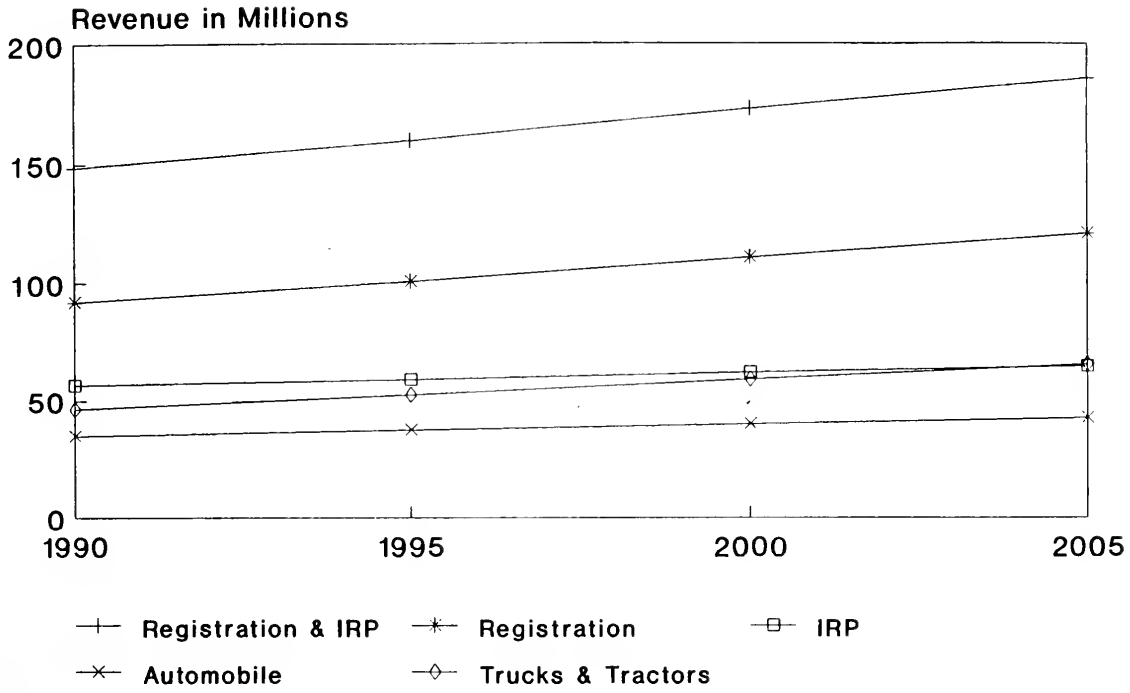


Figure 10. Forecast of Registration and IRP Revenues

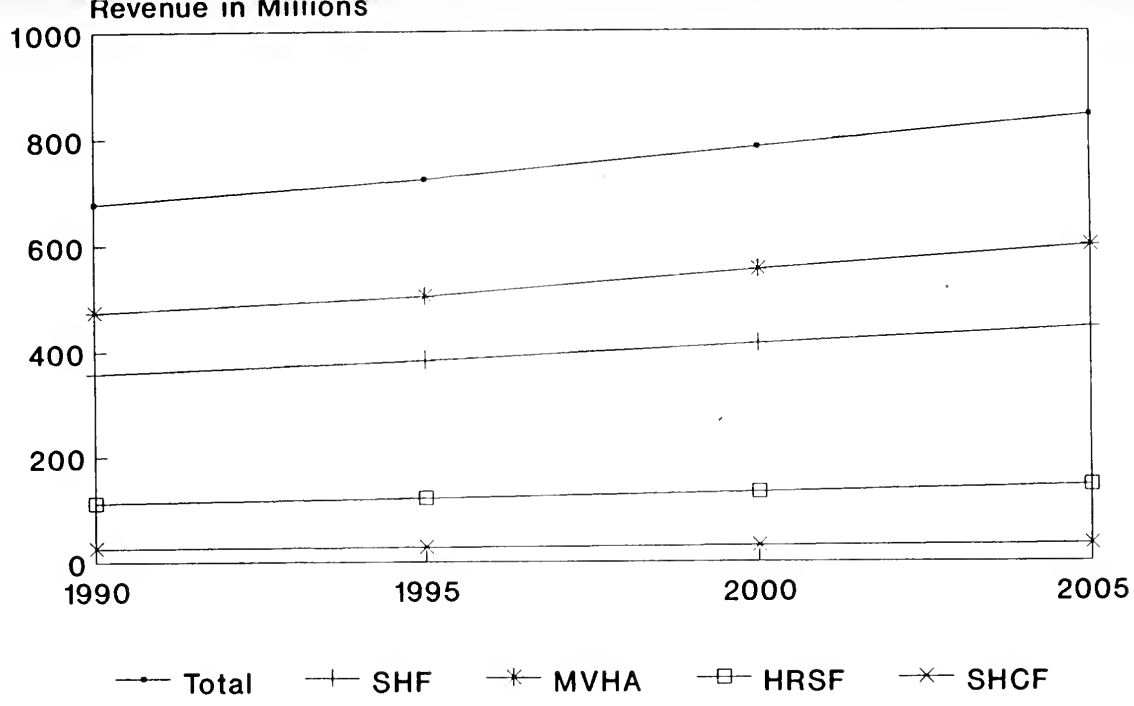


Figure 11. Forecasts of Revenues in Various Funds

contributing the most damage to the facilities is going to increase the least. Total state highway revenues will reach about $843.2 million in 2005. Figure 8 indicates the forecast of highway revenues at state and local levels. Forecasts of motor fuel highway revenues are shown in Figure 9. Forecasts of registration and IRP revenues are shown in Figure 10. Figure 11 indicates revenue forecasts for the various funds in future.

Short-term highway revenue forecasts for the years 1991 and 1992 as obtained by executing INDOTREV program are shown in Table 1 of this report. The short-term results obtained by executing SHORTREV program are shown in Tables 2 and 3. The effects of increasing the tax rates for different revenue sources as of 1991 are presented in Table 4. A penny increase in gasoline tax can generate more than $25 million; whereas, the same increase in special fuel tax fetches only additional $6.3 million. An increase in the automobile registration fee of $1 produces a revenue increase almost 90 times that resulting from increasing the registration fee of non-farm tractors above 78,000 lbs by $5.

Table 1. Short-Term Highway Revenue Forecasts for Indiana, 1991-1992

Month	Registration Fees Revenue		Driver License Revenue	
	1991	1992	1991	1992
J	2571	2615	367	368
F	2259	2298	314	314
M	8881	9034	395	396
A	23224	23695	422	422
M	9660	9827	417	418
J	6856	6974	426	427
J	8959	9113	477	478
A	6700	6815	446	447
S	7167	7291	469	470
O	5609	5706	477	478
N	6388	6498	383	383
D	5142	5230	395	395
	Gasoline Tax Revenue		Special Fuel Tax Revenue	
	1991	1992	1991	1992
J	34628	34888	6428	6490
F	27767	27976	8399	8480
M	29727	29951	8399	8480
A	32341	32584	9427	9521
M	29074	29293	9085	9172
J	36588	36863	7628	7701
J	35281	35546	9684	9778
A	34628	34888	8656	8739
S	34954	35217	8570	8653
O	33321	33571	8142	8220
N	33321	33571	10027	10124
D	30708	30938	8228	8307
	Motor Carrier Fuel Use Tax Rev.		Diesel Surtax Revenue	
	1991	1992	1991	1992
J	1028	1038	7142	7211
F	1491	1506	3513	3547
M	2468	2492	9273	9362
A	758	766	4147	4187
M	1928	1947	4780	4826
J	836	844	7084	7152
J	424	428	1843	1861
A	1748	1765	4550	4594
S	1260	1272	6335	6397
O	1273	1285	6163	6222
N	424	428	5184	5234
D	1800	1817	9158	9246

Table 2. Validation of Forecasts from "SHORTREV"

Year	Month	Vehicle License Fees		Gasoline Revenues	
		Estimated	Actual	Estimated	Actual
1991	JAN	3591070	2679042	36122231	33255441
1991	FEB	3071357	6403422	28515681	30007716
1991	MAR	11876329	9678798	30857179	27139507
1991	APR	31291735	18603313	33427838	32502471
1991	MAY	12984898	13797928	30023112	32941916
1991	JUN	9284509	13358768	37851808	35529035

		Special Fuel Revenues		Diesel Surtax Revenues	
		Estimated	Actual	Estimated	Actual
1991	JAN	6165744	7802452	11967777	1579677
1991	FEB	8546465	10552249	4948390	2400850
1991	MAR	8597732	5703076	13325442	12201246
1991	APR	9671982	8448516	6012074	2873156
1991	MAY	9363750	9051821	7051128	6695545
1991	JUN	7823569	8312538	10489833	2530437

Table 3. Short-Term Forecasts Using "SHORTREV"

Year	Month	Vehicle License Fees	Gasoline Revenues
1991	JUL	12674607	36359952
1991	AUG	9496767	35745766
1991	SEP	10229339	36171900
1991	OCT	7987542	34330813
1991	NOV	9121820	34595754
1991	DEC	7366113	31946918

		Special Fuel Revenues	Diesel Surtax Revenues
1991	JUL	10065615	1950959
1991	AUG	8993414	4895776
1991	SEP	8949771	6868311
1991	OCT	8542809	6711283
1991	NOV	10489610	5678632
1991	DEC	8689893	10183585

Table 4. Effects of Tax Rate Increases on Revenues Generated, 1991

Major Parameter	Action	Effect on Revenue Generated (Increase in 1000s of $)
Gasoline Tax	Increase by 1 cent	25114
Special Fuel Tax	Increase by 1 cent	6321
Diesel Surtax	Increase by 1 cent	4445
Automobile Registration fee	Increase by $ 1	3302
Registration fees of Non-Farm Tractors > 78,000 lb	Increase by $ 5	37